Canting Ballast Twin Foil
Sailing Yacht Ocean Racing Ballast Drive System

CROSS REFERENCE TO RELATED APPLICATION

[00.00] This application claims the benefit of U.S. Provisional Application Serial No. 60/440,453 filed January 15, 2003.

BACKGROUND OF THE INVENTION

1. Technical Field

[01.00] This invention relates generally to sailing yachts, and more particularly to a high performance sailing yacht having a laterally movable ballast suspended beneath the hull that provides a counter heeling force when the yacht is underway.

2. Description of Related Art

[02.00] United States Patents 5,163,377 and 5,622,130 describe various aspects of a keel-less sailing yacht that has fore and aft cambered foils for leeway control and a dynamic gravitational ballast for heeling resistance. A ballast-supporting structure in the form of an elongated strut extending downwardly from the hull supports the ballast generally beneath the hull. The proximal or near end of the strut is mounted on the hull pivotally and

the distal or far end is connected to the ballast. Suitable means are provided (e.g., hydraulic drive components) for swinging the strut between port and starboard limits of travel. That arrangement enables a crew member to move the ballast to desired positions intermediate the port and starboard limits of travel while underway for a desired counter-heeling effect.

[03.00] A keel-less sailing yacht with movable ballast is sometimes referred to as a canting ballast twin foil (CBTF) sailing yacht. Such CBTF sailing yachts enjoy recognized sailing success accompanied by significant interest in CBTF technology. However, various structural and operational concerns need attention. Larger sailing yachts, for example, including those designed for ocean racing or cruising, require greater force to move the ballast-supporting structure. Although hydraulic means have been suggested for prior art canting ballast systems, larger sailing yachts impose structural and operational limitations on a hydraulic cylinder and related hydraulic drive components used to move the ballast-supporting structure. The probability of catastrophic hydraulic component failure increases. Thus, a need exists for a better way to move the ballast on larger sailing yachts.

SUMMARY OF THE INVENTION

[04.00] It is an objective of this invention to overcome the forgoing and other disadvantages of prior art canting ballast systems. This objective is achieved by providing an onboard ballast drive system for moving the ballast under operator control that includes dual hydraulic cylinders connected to different portions of the hulls. Multiple hydraulic pumps may be included along with crossover hydraulic pressure lines to allow any pump to serve any one or two or more hydraulic cylinders. A redundant system with better force distribution results that significantly reduces the risk of failure of any part of the system when engaged in ocean racing or cruising.

[05.00] To paraphrase some of the more precise language appearing in the claims and introduce the nomenclature used, a sailing yacht constructed according to the invention includes a sailing hull, a ballast, a ballast-supporting structure, and an onboard ballast drive system. The ballast-supporting structure functions as means for supporting the ballast beneath the sailing hull moveably in order to produce a counter-heeling force that can be varied underway by moving the ballast-supporting structure. The ballast drive system functions as means for moving the ballast-supporting structure under operator control.

[06.00] According to a major aspect of the invention, the ballast drive system includes at least two hydraulic cylinders. A first one of the two

hydraulic cylinders is mechanically connected between the ballast-supporting structure and a first portion of the hull, while a second one of the two hydraulic cylinders is mechanically connected between the ballast-supporting structure and a second portion of the hull. Preferably two or more hydraulic pumps and crossover valving is included.

[07.00] Thus, the invention provides a sailing yacht that overcomes some significant disadvantages of prior art canting ballast systems while providing functionality that enhances sailing yacht operation. The following illustrative drawings and detailed description make the foregoing and other objects, features, and advantages of the invention more apparent.

BRIEF DESCRIPTION OF THE DRAWINGS

[08.00] FIG. **1** of the drawings is a diagrammatic representation of a canting ballast twin foil (CBTF) sailing yacht with an onboard ballast drive system constructed according to the invention;

[09.00] FIG. **2** is a perspective view of a strut portion of the ballast-supporting structure together with a block diagram of the ballast drive system;

[10.00] FIG. **3** is a perspective view of the strut portion of the ballast-supporting structure along with dual hydraulic cylinders arranged for parallel operation;

[11.00] FIG. **4** is a perspective view of the strut portion with dual hydraulic cylinders arranged for push-pull operation; and

[12.00] FIG. **5** is a perspective view of the strut portion with dual hydraulic cylinders arranged another way for push-pull operation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[13.00] FIGS. **1-5** of the drawings show various aspects of a sailing yacht **10** constructed according to the invention. Generally, the sailing yacht **10** includes a sailing hull **11**, a ballast **12**, a moveable ballast-supporting structure **13**, and fore and aft foils **14** and **15** (FIGS. **1** and **2**). Those components operate in some respects according to known canting ballast twin foil (CBFT) operation, and additional known components of the sailing yacht **10** are not shown for illustrative convenience. Reference may be made to U.S. Patent Nos. 5,163,377 and 5,622,130 for further details of a keel-less CBFT sailing yacht that has fore and aft cambered foils for leeway control and a dynamic gravitational ballast for heeling resistance.

[14.00] For purposes of describing the present invention, suffice it to say that the ballast-supporting structure **13** functions as means for supporting the ballast **12** beneath the sailing hull **11** moveably in order to produce a counter-heeling force that can be varied underway by moving the ballast-supporting structure **13**. The sailing yacht **10** also includes a ballast drive system **16** onboard the sailing hull **11** for that purpose as depicted in block diagram form in FIGS. **1** and **2**. The ballast drive system **16** is mechanically connected to the ballast-supporting structure **13**, as depicted by a bold line **17** in FIG. **1**, and it functions as means for moving the ballast-supporting structure **13** in order to move the ballast **12** and thereby vary the counter-heeling force. An operator can control ballast position with the ballast drive system **16** while underway for maximum righting moment, safety, and shock mitigation.

[15.00] Any of various drive mechanisms may be used to perform that function, including a hydraulic form of ballast drive system. The drive system **16** is such a hydraulic drive system as depicted in block diagram form in FIG. **2**. According to a major aspect of the invention, the hydraulic ballast drive system **17** includes at least two hydraulic cylinders. They are identified in FIG. **2** as a first hydraulic cylinder **18** and a second hydraulic cylinder **19**. They may take the form of known components and they are installed as multiple hydraulic cylinders connected to the hull **11** and a strut portion **20** of the ballast-supporting structure **13** in order to provide

greater force and redundancy that helps avoid catastrophic failure underway.

[16.00] Preferably, the first and second hydraulic cylinders **18** and **19** are connected to different portions of the hull **11** for better force distribution. Thus, the first hydraulic cylinder **18** is mechanically connected to a first portion **11A** of the hull **11**, as depicted in FIG. **2** by a bold line **18A**, and to the strut portion **20**, as depicted by a bold line **18B**. Similarly, the second hydraulic cylinder **19** is mechanically connected to a second portion **11B** of the hull **11**, as depicted in FIG. **2** by a bold line **19A**, and to the strut portion **20**, as depicted by a bold line **19B**. That arrangement provides a better distribution of the forces transmitted by the first and second hydraulic cylinders **18** and **19** to the hull **11**.

[17.00] In operation, an operator uses operator controls **21** to control a motor and pump system **22** and valving **23** to control the flow of hydraulic fluid from a hydraulic fluid reservoir **24** to the first and second hydraulic cylinders **18** and **19**. The motor and pump system **22** is operatively connected to the two hydraulic cylinders **18** and **19** via the valving **23** and it includes at least two hydraulic pumps (not individually shown) in order to provide hydraulic pump redundancy. Individual pumps are not shown for illustrative convenience, but they may take the form of known hydraulic components.

[18.00] Hydraulic fluid pumped by the motor and pump system **22** to the first hydraulic cylinder **18** via the valving **23** and a first hydraulic line **25** causes the first hydraulic cylinder **18** to extend, while hydraulic fluid pumped by the motor and pump system **22** to the first hydraulic cylinder **18** via the valving **23** and a second hydraulic line **26** causes the first hydraulic cylinder **18** to retract. Similarly, hydraulic fluid pumped by the motor and pump system **22** to the second hydraulic cylinder **19** via the valving **23** and a third hydraulic line **27** causes the second hydraulic cylinder **19** to extend, while hydraulic fluid pumped by the motor and pump system **22** to the second hydraulic cylinder **19** via the valving **23** and a fourth hydraulic line **27** causes the second hydraulic cylinder **19** to retract. As they extend and retract under operator control that way, the first and second hydraulic cylinders **18** and **19** cause the strut portion **20** to pivot about a pivotal axis **20A** in order to thereby move (or swing) the ballast-supporting structure **13** and the ballast **12** to a desired position relative to the hull **11**. Based upon the foregoing and subsequent descriptions, one of ordinary skill in the art can readily implement a CBTF sailing yacht with an onboard ballast drive system according to the invention.

[19.00] Turning now to FIG. **3**, it shows first and second hydraulic cylinders **38** and **39** connected to the strut portion **20** and to first and second hull portions **31A** and **31B** as described for the first and second hydraulic cylinders **18** and **19** in FIG. **2**. They are also connected by

hydraulic lines and to the valving **23**, but those details are omitted for illustrative convenience. The first and second hydraulic cylinders **38** and **39** are arranged for parallel operation. They extend together and retract together. In the event one cylinder fails (including failure of hydraulic line coupling hydraulic fluid to it or the related pump and/or valving), the other cylinder assumes the full load. This redundancy helps avoid catastrophic failure underway.

[20.00] FIG. **4** shows first and second hydraulic cylinders **48** and **49** connected to the strut portion **20** and to first and second hull portions **41A** and **41B** as described for the first and second hydraulic cylinders **18** and **19** in FIG. **2**. They are also connected by hydraulic lines and to the valving **23**, and those details are omitted for illustrative convenience. The first and second hydraulic cylinders **48** and **49** are arranged for push-pull operation. As the first one extends, the second one retracts. As the first one retracts, the second one extends.

[21.00] FIG. **5** shows first and second hydraulic cylinders **58** and **59** connected to the strut portion **20** and to first and second hull portions **51A** and **51B** as described for the first and second hydraulic cylinders **18** and **19** in FIG. **2**. They are also connected by hydraulic lines and to the valving **23**, and those details are omitted for illustrative convenience. The first and second hydraulic cylinders **58** and **59** are also arranged for push-pull operation.

[22.00] Thus, the invention provides a sailing yacht that overcomes some significant disadvantages of prior art canting ballast systems while providing functionality that enhances sailing yacht operation. Although exemplary embodiment have been shown and described, one of ordinary skill in the art may make many changes, modifications, and substitutions without necessarily departing from the spirit and scope of the invention.

[23.00] What is claimed is: